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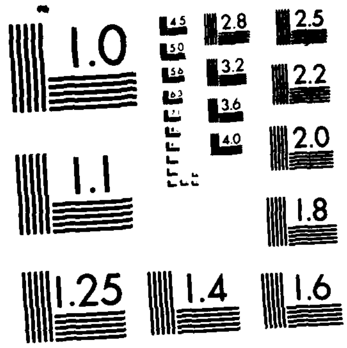

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NSWC TR 85-382

AD-A164 627

IMPROVED DESIGNS FOR ISOCON CAMERAS IN HERTR SYSTEMS

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7 JUNE 1985

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The HERTR imaging systems are experiencing Isocon tube failures at a rate which is not typical of more intensely used imaging systems containing Isocon tubes. Heat is the usual cause for early Isocon tube failures. A HERTR system was visited and it was decided that, indeed, heat was the probable cause for failure. A mechanical design was prepared which was as similar as possible to the major confining structure surrounding the HERTR camera. In subsequent tests with the duplicate structure, the thermal failure mode was duplicated without continuing the tests to completion. A design change was

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initiated and tested with the duplicate system. Thermal characteristics of the altered system were measured.

Additional deficiences in the HERTR imaging system were noted during the course of the visit to the HERTR site. These deficiences are also described in this report.

Recommendations are made to alter the HERTR design to include the modifications made to the duplicate camera design. In the short term these modifications are simple and inexpensive to implement. Recommendations are also included for an extensive modification to high energy imaging systems, particularly those subject to pulsed operating conditions and to those operating in photon limited situations which is usual in x-ray imaging systems

EXECUTIVE SUMMARY

The HERTR imaging systems are experiencing Isocon tube failures at a rate which is not typical of more intensely used imaging systems containing Isocon tubes. Heat is the usual cause for early Isocon tube failures. A HERTR system was visited and it was decided that, indeed, heat was the probable cause for failure. A mechanical design was prepared which was as similar as possible to the major confining structure surrounding the HERTR camera. In subsequent tests with the duplicate structure, the thermal failure mode was duplicated without continuing the tests to completion. A design change was initiated and tested with the duplicate system. Thermal characteristics of the altered system were measured.

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FOREWORD

This report describes work performed on the imaging camera contained in the HERTR system and was sponsored by the Naval Surface Weapons Center, Contract Number N60921-85-C-0063.

This contract was the result of a competitive bid submitted in response to a request by the US Navy included in the Small Business Innovation Research solicitation of 1984. This contract was monitored by Mr. J. M. Warren, Code R34, Naval Surface Weapons Center, White Oak, Silver Spring, MD 20903-5000.

Work on this contract was performed by Joseph J. Stafford of J. Stafford Associates.

Approved by:

Jack R. Dixon

JACK R. DIXON, Head
Materials Division

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INTRODUCTION

The Isocon camera used within the HERTR imaging system has been experiencing repetitive tube failures. As the camera tube is a relatively expensive component and because this particular tube type characterizes the nature of the imaging system, a program was begun to: a. isolate the cause for the early tube failure, and b. suggest a more appropriate imaging system which would not be subject to such early failure and which, at the same time, would perform as well as the existing system. Replacement of the Isocon tube or isolation of the cause of the early failure would both reduce the cost of maintaining the system and would also improve the effectiveness of the X-ray system due to reduced down time.

Without direct knowlege of the cause for the tube failures in the HERTR systems, but with extensive experience with Isocon type cameras, JSA undertook the task to initially isolate the cause of the early failure, and then suggest a methodology to remove the source of failure either through a minor design change or a major system modification. This report details the activities occuring during the 6 month test period within which time the cause of and remedy for the tube failure was identified. Other sources of lower than expected performance were also identified during this period. The results of this investigation will form the basis for an improved camera system which will be proposed in a separate document.

TECHNICAL ACCOMPLISHMENTS

In order to improve the design of the existing cameras in the HERTR systems, a model of the present design with its limitations had to be presumed. The cause for the camera deficiency, particularly with respect to the camera tube, was not included in the project description from which this program derived. For this program it was presumed that the major problem area was thermal in nature. This assumption was based on previous experiences with Isocon tubes. In order to verify that the problem was in fact due to thermal conditions existing in the present design, a model of the HERTR camera was required. In addition, in order to examine already damaged tubes which the Navy had in its possession, the model had to be a fully operating camera. Photographs of a similar camera manufactured by the current supplier to Lockheed were taken and some rough dimensions were also obtained. With this information a camera enclosure was designed and fabricated. In addition, a similar lens, deflection yoke assembly, and a test Isocon tube were obtained. Again presuming on the nature of the camera deficiency, an additional focus coil was ordered with the proper modifications added. The presumed problem had been encountered

before in a system similar to the HERTR system but without the particular environment surrounding the HERTR systems. The HERTR cameras are cooled by means of a special heat exchanger included in the camera enclosure. This cooler should be able to maintain the Isocon tube within the recommended temperature range if the proper means of moving the cooling air is also provided. The modifications of the additionally procured focus coil would aid in accomplishing the cooling task by reducing the power consumed in driving the focus coil and by providing a cleaner air flow through the focus coil assembly.

While the mechanical design was being executed and the various components were in the process of being shipped, attention was directed toward the electrical design. A set of printed circuit boards were available from an earlier designed 2 inch Isocon camera. These boards were modified as needed and additional peg boards were added where necessary. The operation of the two tube types (2 inch vs. 3 inch) is similar but sufficiently different that additional circuitry was necessary. Some of the modifications to the circuitry had to await the assembly of the camera mechanical components. In addition, the focussing coil in the HERTR camera requires a higher voltage power supply than is available in the 2 inch camera. This is due to the higher resistance (62 ohms vs. 9 ohms) of the focus coil in the HERTR camera.

When the mechanical components arrived, the entire assembly was tested for thermal heat rise with a tube, lens, and deflection components in place. Only the focus coil was driven from a temporary power source. Temperature measurements were made using the thermistor which is mounted on the deflection yoke immediately behind the region where the target of the Isocon tube is normally positioned. This thermistor was previously calibrated in a water bath over a temperature range of 68 to 140 degrees Farhenheit. An additional thermistor was mounted on the glass wall of the tube at a location in front of the tube target. Also, other thermal sensors were positioned further down on the tube neck. Preliminary data was taken to establish the relative temperature rise which might be expected as a function of location of thermal sensor.

In conjunction with these measurements, the rear of the camera housing was modified to allow the inclusion of either a fan or a displacement pump in the design. The fan selected was of a type which is normally included in the camera package as supplied by Penn Video, although the camera supplied to Lockheed may be configured differently. The thought behind these measurements was that if the pressure head required to pull enough air through the camera-deflection yoke interspace to sufficiently cool the tube target was too high for a simple fan, then the displacement pump could be used. Provision was made to measure the pressure head for

either cooling device. Flow measurements were made for the displacement pump only.

Eventually a complete camera was assembled and tested with both a rejected tube obtained from the Navy and another rejected tube obtained from an industrial user. Both the original focus coil (62 ohms) and the modified focus coil (36 ohms) were tested with respect to the focus field measured on axis. The thermal behavior was measured over an extended period of time with and without the cooling provided by the fan. In some cases a modified rear support ring was used to open the air path between the focus coil and the deflection coil. The same deflection coil was used with both focus coils. Thermal measurements were also made with the normal rear mounting ring in place. Measurements were made with a lens having an extended rear focal distance as well as with the lens that is nomally used in the HERTR imaging system. The very short back focal distance of the HERTR lens can effectively plug the front of the deflection assembly and thus inhibit sufficient air flow to effect proper cooling of the Isocon tube. The effect of this flow obstacle was measured.

In the course of the program, a reject Isocon tube furnished by the Navy was evaluated. Actually 2 tubes were delivered but one of the tubes was broken when delivered and was returned to the Navy. The retained tube was used exclusively in all tests until it too failed in a non test related manner. The failure is not judged to be permanent but precluded any further testing without repair.

A visit was made to the Hercules company for the purpose of familiarizing JSA with an actual installation of a HERTR system. Discussions were held with both the operating and repair personnel. In addition, data was taken with respect to operating conditions including the operating environment. Unfortunately, the visit occurred during an active use period which limited the extent of the investigation of the several shortcomings noted in the system performance. The detailed records of the maintenance personnel were examined with respect to previously noted failures, operating conditions, and recommendations for improvements. The extent of the understanding of the system deficiencies and of the various techniques which could be employed to bring about an overall improvement in system performance was somewhat unusual and is a tribute to the attention and interest of the maintenance individual.

DETAILED RESULTS

In order to appreciate the results of this program, an

understanding of the deflection assembly is very helpful. A deflection assembly is composed of five components. They are listed as follows:

a. The deflection yoke, or deflection coil, lies immediately above the camera tube and provides the physical socket for the shoulder pins located on the rear of the head of the Isocon tube. In addition, the rear of the Isocon tube is supported on rubber snubbers located at the rear of the deflection yoke. In the region of the shoulder socket and extending into the space separating the socket from the tube, a thermistor is located. A themistor is a thermally sensitive resistor having a negative temperature coefficient characteristic. The calibration curve for the thermistor type used in the Isocon yoke is shown in Figure 1.

b. The focus coil is a simple solenoid winding surrounding the deflection yoke and extending both in front of the deflection yoke and behind the deflection yoke. As in all solenoids, the magnetic field is simply determined by the product of the number of turns and the current driven through the turns or coil. The shape of the magnetic field is determined by the physical location of the axially wound turns. The power disipated in the coil is determined by the resistance of the wire which makes up the solenoid which, in turn, is determined by the diameter of the wire itself. The wire used in the focus coil of the HERTR camera is such that the resistance of the solenoid is approximately 60 ohms. The required current for proper camera operation is nominally 600 milliamperes. The power dissipated in the focus coil is therefore, roughly 22 watts. A more appropriate coil is one wound with larger wire and having the same number of turns. This coil has a resistance of 36 ohms and, since the same current is required, the power dissipated is only 13 watts. The magnetic flux measurement, on axis, for both coils is shown in Figures 2 and 3. This plot for the high resistance coil, as shown in Figure 2, is measured for two different currents in order to establish the axial magnetic equivalence for the two coils. That is, the coils are magnetically equivalent when the high resistance coil is driven with 585 milliamperes and the low resistance coil is driven with 607 milliamperes. Only the plots of the magnetic flux for the front of the coils are shown, although the uniformity of the flux along the entire length of the coil has been measured. The focus coil is easily separated from the deflection yoke.

c. The faceplate coil is located at the very front of the focus coil and is removable to allow the insertion of the tube into the deflection assembly. This coil is inserted in series with the main focus coil and can be used to shape the flux field in the front of the deflection assembly. The faceplate coil, therefore has the same current flowing through its windings as the main coil does through its windings. An auxilliary function of the faceplate coil is to position the tube in the deflection assembly since the tube is typically pressed against this coil by means of springs located

in the rear portion of the deflection yoke. The same faceplate coil was used in all measurements, shown in Figures 2 and 3, for both main focus coils. The resistance of the faceplate coil is typically 2 ohms.

d. A rear mounting ring is located at the rear of the deflection assembly. Its main function is to firmly position the deflection yoke with respect to the focus coil. In the deflection assemblies furnished to Penn Video, who in turn supplies the cameras to Lockheed, this ring is usually a spun brass, or aluminum, cup. During the visit to Hercules, the shape and style of this ring was not noted, unfortunately. In any case, this spun piece physically completely blocks the interspace between the focus coil and the deflection yoke. There can be no air flow between these two components in this configuration. An improved ring was inserted and tested with both focus coils. In the improved ring, which is machined from a solid disc of aluminum, the interspace between the deflection yoke and the focus coil is substantially maintained clear with the exception of three tabs to locate the deflection yoke. The results of this change will be discussed shortly.

e. The overall shield is made up of a spun magnetic material. A cut out in the front of the shield radially locates the front of the focus coil, and the rear mounting, just discussed, axially locates the shield with respect to the remaining components. The same shield was used in all measurements. Over the entire length of the deflection assembly the shield is maintained cylindrical in shape by means of carefully machined insulating rings positioned on the focus coil. The function of the shield is to protect the tube/yoke assembly from external magnetic fields rather than providing a low reluctance return path for the focus field. The low reluctance return path is provided by means of wound magnetic material located immediately around the focus coil. It is important to note this be cause the air gap between the wound material and the outer shield negates the effectiveness of attempting to cool the outside of the shield. In some deflection assemblies this air space is filled with metal loaded epoxy in an effort to cool the deflection assembly. Such a yoke was not evaluated in this program.

Three changes in the deflection assembly were evaluated in this program. These were:

a. focus coil resistance,
b. rear mounting ring, and
c. degree of closure of front of the deflection assembly by the imaging lens.

This last variable, the location of the lens, is most crucial. In the design of the Canon f/0.7 60 mm. lens, the rear focal distance is 3.5 mm. in air. Since the front of the Isocon tube is made of clear glass, the glass thickness, which is approximately 2.5 mm., effectively reduces the air gap between the lens and the tube face

to virtually nil. Also, if the front of the tube is located deep in the deflection assembly, the lens body will effectively plug the clear diameter of the focus coil and restrict the flow of air to the tube/ deflection interspace. Consequently, this interference condition must be evaluated. In these tests to be described the effect of the lens position was evaluated using two different lenses, one with a very long back focal distance, and the Canon lens, with its very short back focal distance. From a practical point of view, these measurements have little bearing on the HERTR system since this system uses a dioptar correction lens in front of the Canon lens. This dioptar lens increases the field of view and increases the back focal distance, i.e. the magnification is increased and the effective speed of the lens is reduced. This condition, the increased back focal distance , was verified during the visit to Hercules. In the HERTR system the front of the deflection assembly is relatively clear.

The methodology used in the thermal tests was as follows: the camera assembly is powered on, the picture beamed on, and the resistance of the thermistor noted. The camera had been properly set up at an earlier time so that all thermal measurements would begin from an essentially room temperature ambient condition. Upon reaching a temperature of 122 degrees Farhenheit, power was removed from the camera while the continual rise in temperature was measured. When the temperature increases ceased, power was reapplied, and, either at the same time or shortly therafter, as noted in the Figures, the fan was activated. The noted temperature decrease was usually swift. Temperature measurements were made at various intervals, usually every 5 minutes during the heat rise period and typically every 15 seconds during the thermal fall period until an asmyptoting was noted.

Several characteristics are to be noted in the accompanying Figures 4,5,6,7,and 8. Comparisons of Figures 4 and 5 measure the effect of a slightly open and a very much open yoke assembly. The slightly open condition is established with the Canon lens. Optical focus with the high resistance focus coil allowed sufficient clearance to between the lens and the tube to allow cooling air to pass into the yoke in sufficient quantity to cool the thermistor. The setup in Figure 4 is representative of the current situation in the HERTR system. Note the approximately 70-80 minutes required to bring the thermistor to 122 degrees.

Compare Figures 4 and 6. Now the lens opening is setup very clear and the rear mounting ring is changed to a very open condition. Note the very much more rapid drop in temperature after application of cooling air and the narrower the difference between ambient and thermistor temperature. The ambient room temperature was actually lower for the test measurements shown in Figure 6

than those shown in Figure 4. Other system measurements had been undertaken prior to the beginning of taking data for the run described in Figure 6 and the camera hadn't been allowed to come to a fully cooled down condition.

Compare Figures 5 and 7. The lower resistance focus coil was used during the run described in Figure 7. This coil required that the lens, the Canon, completely block the deflection assembly front opening in order to achieve optical focus. The long, relatively slow cool down rate indicates that the air flow is partially blocked. This condition could be relieved if the lens was only slightly defocused. The camera assembly was designed in such a way that the lens focus was controlled with a differential screw. Differential screw action was such that the lens moved just under .015 inches per revolution or turn. Less than 1/2 turn would cause the temperature drop to increase significantly. From a just open condition as just described to a fully closed condition as was the initial condition, the temperature would actually rise rather than continue to fall. Now the heat input rate exceeded the cooling rate. Also note the longer period required to bring the thermistor to 122 degrees.

Compare Figures 4 and 8. Now the focus coils are different, and the rear mounting rings are different. The time required to heat the thermistor without the benefit of cooling is more than doubled, the rate of cooling is increased, and the asmyptotic temperature is closer to room temperature. The configuration represented in Figure 8 is the appropriate design for this camera.

It is important to understand that this data was taken in a less than normal configuration, i.e. there was no cooling applied for the first considerable length of time. A final test was made on the optimum configuration, that existing for data shown in Figure 8. With full power applied and in an ambient room temperature varying from 66 to 72 degrees Fahrenheit, the temperature rise was monitored over a period of just under 200 minutes. The temperature of the themistor rose from 75 to 91 degrees. During a similar test but under less than optimally controlled circumstances, the HERTR camera rose 5 degrees in less than 35 minutes. At the time of the HERTR measurement the outside temperature was below freezing and the internal temperature of the cooling air pumped from the heat exchanger was probably near 50 degrees Fahrenheit. The conclusion to be drawn from this data is that the HERTR camera is not being as adequately cooled as possible. A simple design change would allow proper cooling.

As was stated earlier, the Isocon tube which served in the earlier portions of the thermal measurements was furnished by the Navy from Lockheed stores. This tube, numbered U 7360, was sup-

posedly damaged and of little value. The reported defects consisted of excessive shading and strange patterns in the video presentation. Data available from Hercules on this same tube indicated that the image section voltage was substantially different from that of a new or satisfactory tube. The label on the tube was marked when received as "cooked" indicating that some thermal exposure had been experienced by the tube. In fact, the tube behaved as described by Hercules personnel. This was caused by the imaging voltage being pulled very much lower than the unloaded power supply was set for. Eventually, this condition cleared itself and the tube appeared to be very normal in behavior and the power supply indicating that the image section was not being loaded to any abnormal degree. In this camera, all negative voltages are derived from a common multiplier chain so that any tube electrode requiring a negative voltage could be the cause of the problem while the most obvious difference would point to the higher impedance terminals on the power supply. Hence, the imaging section was blamed. Partially through the various tests the trouble manifest itself again but with a much more solid condition,i.e. the tube could not be turned off with the beam control. Measurements on the pins of the tube itself, beyond the decoupling network in the tube socket, indicated that the grid 1 voltage was indeed positive rather than negative. Removal of the tube and further tests indicated that the tube had developed a grid 1 to filament short. No damage was done to the electronics and inspection of the tube indicates that the difficulty is probably not even inside the tube, but rather inside the external socket which is glued to the base of the tube. The pins which are suspect are number 1 and 2 which are obviously located next to each other in the socket but are relatively remote beyond the tube base within the vacuum envelope. While this tube was operating, the pictures generated were very presentable and the tube indicated no symptoms as was reported. After the eventual failure the tube was repackaged and no attempt was made to repair the damage, there being no authorization to do so. The repairs would be quite simple to accomplish as this type of failure is not without precedent. The tube itself is probably worthless as a system component since there are some artifacts in the picture probably caused by the excessive handling to which the tube has been subjected.

The visit to Hercules was very informative in that other system shortcomings were noted. The primary observation would have to be concerned with the inconsistent ability of the operator to observe detail in the picture regardless of where the detail was located in the picture. This situation was reported by the maintenance personnel who experienced this effect during camera setup. The estimated cause of this effect is strictly based on conjecture although similar effects have been noted in medical applications. The most probable culprit is the Isocon tube coupled with the pulsed source particular to high energy or high flux applications. One of the beneficial attributes of the Isocon is the lack of a

lag characteristic. The target of the Isocon is a non storing element, and, in fact, any attempt to integrate picture detail on the target for even short periods of time usually meets with little or no success. Since the energy source is a pulsed nature in the HERTR system, the picture detail will look optimum immediately after the pulse is terminated. Between pulses the picture will deteriorate in detail until just after the next pulse. Physically each pulse is spacially separated by approximately 88 raster lines. Some of these lines are buried in the vertical retrace period, particularly since the camera is line locked. In this case the x-ray is pulsed at the time vertical blanking is asserted, when the monitor beam is in the lower right corner. These estimates are based on a pulse repetition rate of 180 pulses per second. This characteristic loss of picture detail, caused by lateral leakage in the Isocon target, is further aggravated as the target becomes warm. On the other hand, symptoms of a target operating too cold is referred to as "sticky" implying the smearing of video detail if the object being x-rayed is in motion. In effect the target is integrating the video detail. Since most of the analysis accomplished with the HERTR system is done in an integrated mode with the object held stationary, smearing should present no difficulty, and deterioration of the video image due to lateral leakage of the target caused by excessive heat would be reduced. In the HERTR system, operation in a somewhat cooler environment would appear to offer an improved performance of the Isocon tube.

Other minor anamolies noted during the course of the visit to Hercules include an apparent pattern in the video output which runs at approximately 20 degrees from vertical throughout the picture. This may be caused merely by a misalignment of the internal mask on the target with the deflection yoke. There was a rather obvious lacking of vertical blanking on the video monitor located in the image processing rack. Non of these shortcomings were judged to cause an interference with the normal operation of the system.

RECOMMENDATIONS

The overall assessment of the HERTR system is that the design is quite adequate with respect to the camera, and deficient in the selection of image processing hardware and video tape recorder. While there are some reservations regarding the overall camera design, the most serious deficiencies are those causing the early camera failures and the apparent lack of concern exhibited by the tube manufacturer, the camera designer, and the system assembler. The cause of the tube problem has been known for a long time as a representative of each of the responsible companies has visited the site and arrived at the same conclusion as this report

does. And the problem persists. Clearly, an adequate supply of cooling air is available from the heat exchanger. Just as clearly, this cooling air is not being delivered to the tube/yoke assembly. This problem with adequately cooling the Isocon tube is well known and has existed even with Orthicon type cameras. The data sheet for the 21204 type Isocon states that the maximum bulb temperature at any location should not exceed 65 degrees centigrade, and that the target temperature range should be maintained between 30 and 50 degrees centigrade. The 21204 type Isocon contains a bialkali photocathode as does the 8673 type Orthicon and the data sheet for the 8673 is much more specific. "Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge results..... No part of the bulb should run more than 5 degrees Centigrade hotter than the image section to prevent cesium migration to the target. Such migration will result in loss of resolution and in probable permanent damage to the tube". The quotation marks define the instructions found in the older Orthicon data sheets and would seem to offer good advice for the Isocons as well.

Specifically the following steps are recommended to alleviate the problems currently encountered in the HERTR systems.

a. Remove the present focus coil assembly and replace it with a similar unit having a lower series resistance. As shown in Figures 2 and 3, they can be made magnetically equivalent.

b. Remove the rear mounting ring on the existing assembly and replace it with a specially machined ring which will allow more direct application of the cooling medium to the region causing the present difficulty.

c. The present system has too wide a clearance around the outer perhiphery of the entire deflection assembly. In an effort to direct more cooling air into the tube/deflection region, this clearance should be reduced. The easiest manner to achieve this goal is to slip a 4 1/4 inch * 1/8 inch "O" ring over the magnetic shield and locate this ring in the region of the bulkhead supports. This can be done at any one or more of the three bulkheads.

d. The installation of the HERTR camera is supposed to include three flexible hoses to conduct the cooling air to and from the camera. Two of these hoses deliver freshly cooled air, while the third acts as an exhaust back to the heat exchanger. Presumably the exhaust pressure is zero. In the system at Hercules this exhaust tubing is missing. If the exhaust pressure head is zero, the missing hose is unimportant. The airflow presently feels less than adequate, but no measurements were made and modification of the in place camera would have violated the qualification documen-

tation. The first instinct is to add an exhaust fan to the return port. Unfortunately, three fans in series will act no better than the poorest of the lot in a closed loop system. The fans within the heat exchanger may also have to be modified or replaced. If the first three recommendations are followed, the inclusion of a third fan may not be necessary or even desirable. While the air flow into the camera seems low, the temperature of the air feels sufficiently low to assure adequate cooling if only properly directed. A recommendation is to incorporate the first three modifications, conduct further tests, and pursue the application of new or different fans as a final step. Addition of an exhaust fan will require an interface plate and some drilling of mounting holes for this plate.

Accomplishing the above recommendations should cost less than $10,000.00 and require less than 8 hours of down time per camera. The only significant material cost is for the new focus coil assembly. There should be no modifications necessary to the camera unless the air flow is used to maintain the camera temperature within a narrower range than is now possible. In that case the air flow could be interrupted (turned off) until a 40 degree temperature is reached and reapplied until a 35 degree temperature is reached. The same control circuitry as now exists in the camera is usable with the controlled power now that necessary to drive the fan. The addition of one solid state relay may be required. With this additional feature less loss in resolution due to lateral leakage in the interpulse period will be realized. The current limits of resolution should be the image processor and the 512 pixel horizontal constraint.

e. A final recommendation is to continue to direct support to the replacement of the Isocon tube. Due to the limitations of the Isocon when operated in a pulsed input condition, significant improvement is not likely in the foreseeable future. Cooperation with the tube manufacturer in improving the design is also unlikely since the future appears to be directed toward solid state devices. A further improvement in system performance is possible with an improved lens design. From an information transfer consideration, the limiting component in the camera is the signal to noise characteristic of the camera itself, which, in turn, is limited by the optical pickup or lens. In the present system the Canon lens is less than 1 % efficient in gathering light photons emitted by the fluorescent screen. This can be easily determined by measuring the solid angle defined by the lens and comparing that with the total flux contained in a lambertian source such as the screen. This camera operates in a photon limited condition most of the time, particularly when examining small detail. Therefore, it is important that an optical system be used which is as efficient as possible. In order to achieve these goals continued work should be directed toward:

1. Improving the optical pickup characteristic; and
2. Replacing the Isocon tube with a pickup device more compatible with operation in pulsed systems.

These topics will be the subject of a followup proposal for Phase II funding.

SUMMARY

The cause for the early failure of the Isocon tubes in the HERTR imaging system was suspected to be due to thermal problems brought on by inadequate cooling. This suspicion was verified during a visit to a major user of the HERTR systems, Hercules, and was verified in the laboratory of JSA. A duplicate system to the HERTR sub chassis was designed, fabricated, assembled, and tested. Sufficient circuitry was added to an already existing design to test the cooling mechanism as well as to test a damaged Isocon. The cooling mechanism was improved and shown to be easily implemented into the existing HERTR design with minimal costs. In addition, other deficiencies in the HERTR system were noted, particularly with respect to the lens collection efficiency and the pickup tube when used in a pulsed energy applcation. Recommendations for the improvement of the HERTR system are offered. These improvements could be furnished be JSA or other suppliers although the lack of sufficient interest on the part of the previous suppliers is noted.

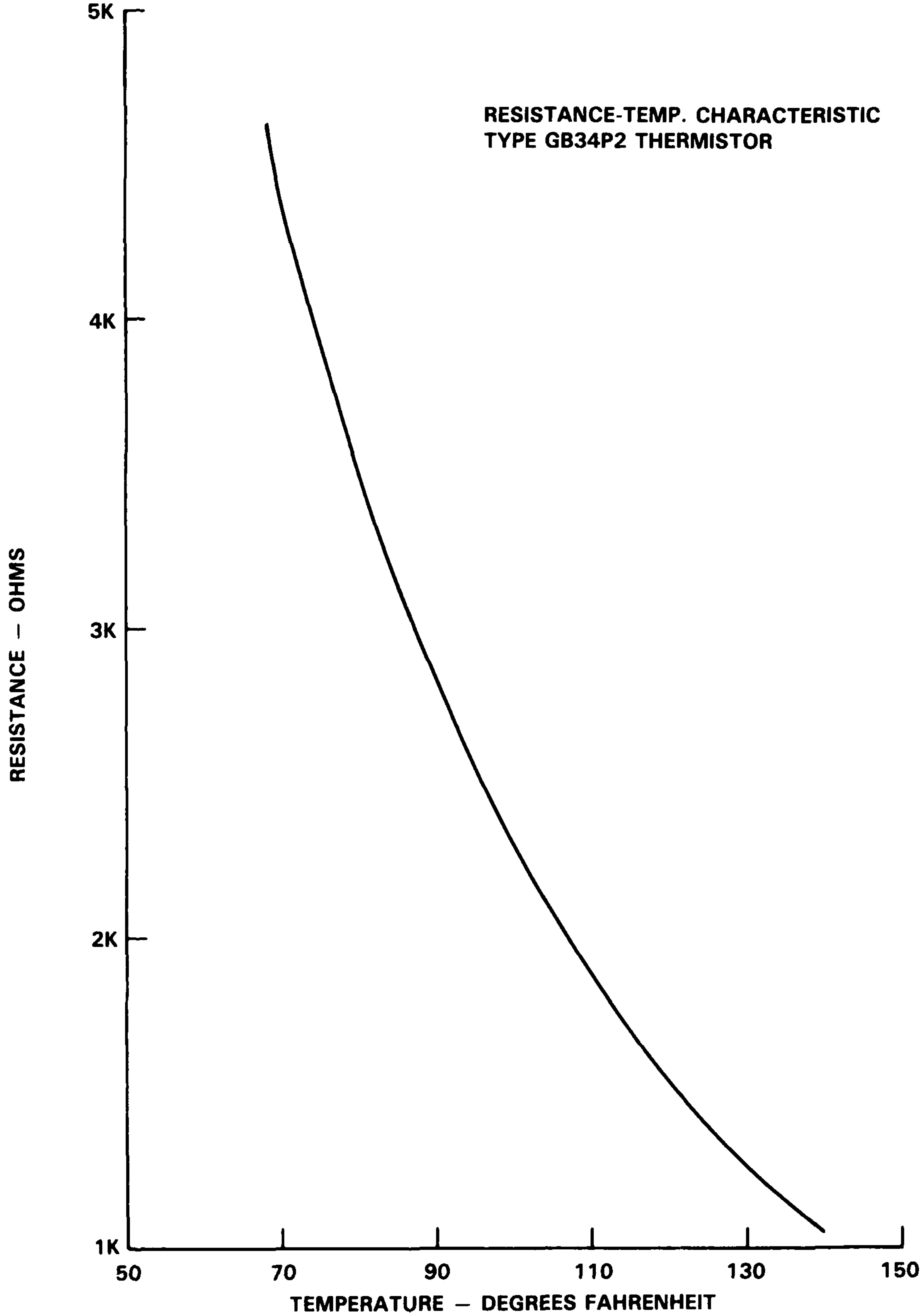

FIGURE 1. RESISTANCE/TEMPERATURE CHARACTERISTIC OF THERMISTOR

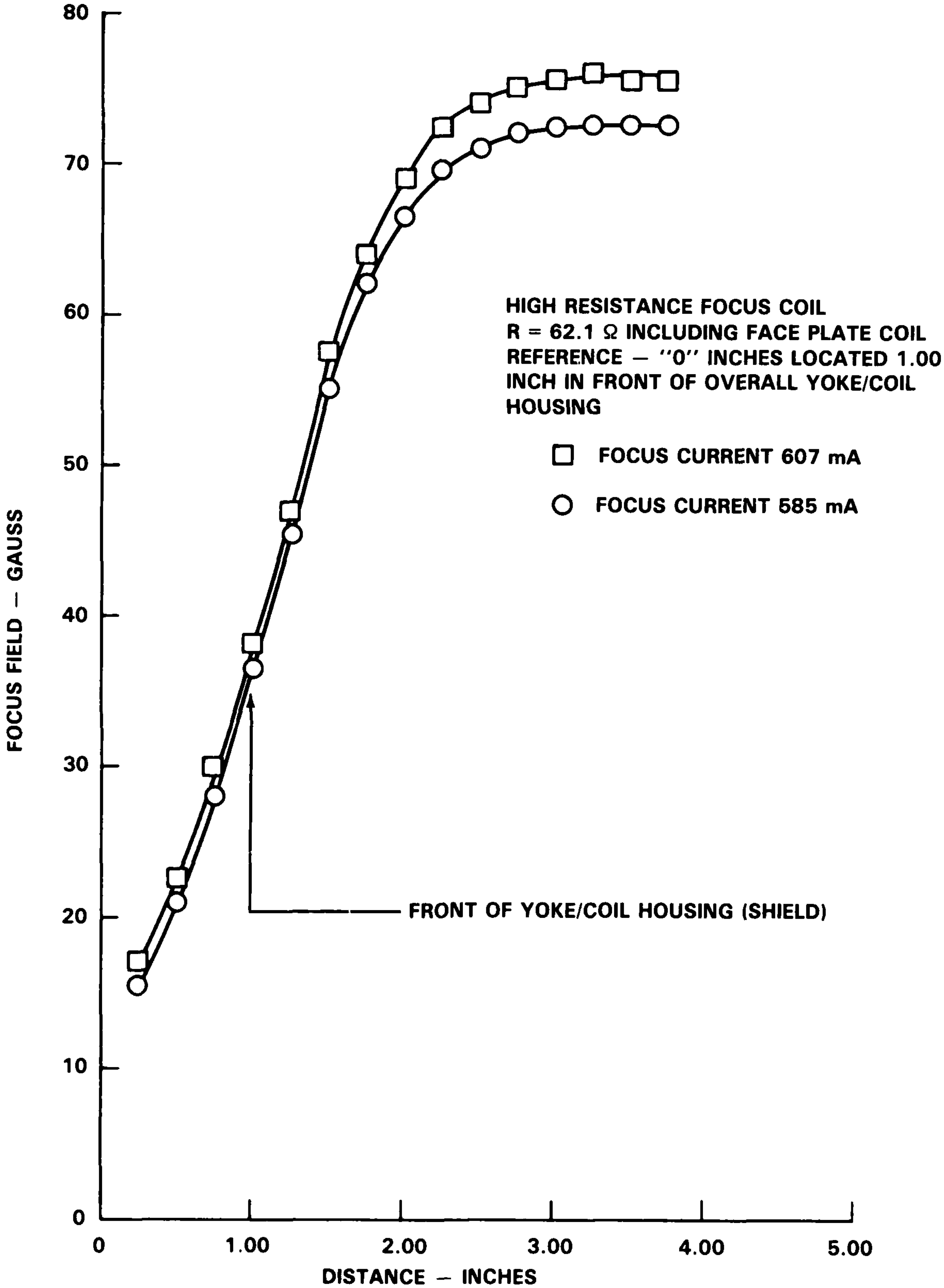

FIGURE 2. MAGNETIC FIELD FLUX PLOT — HIGH RESISTANCE FOCUS COIL

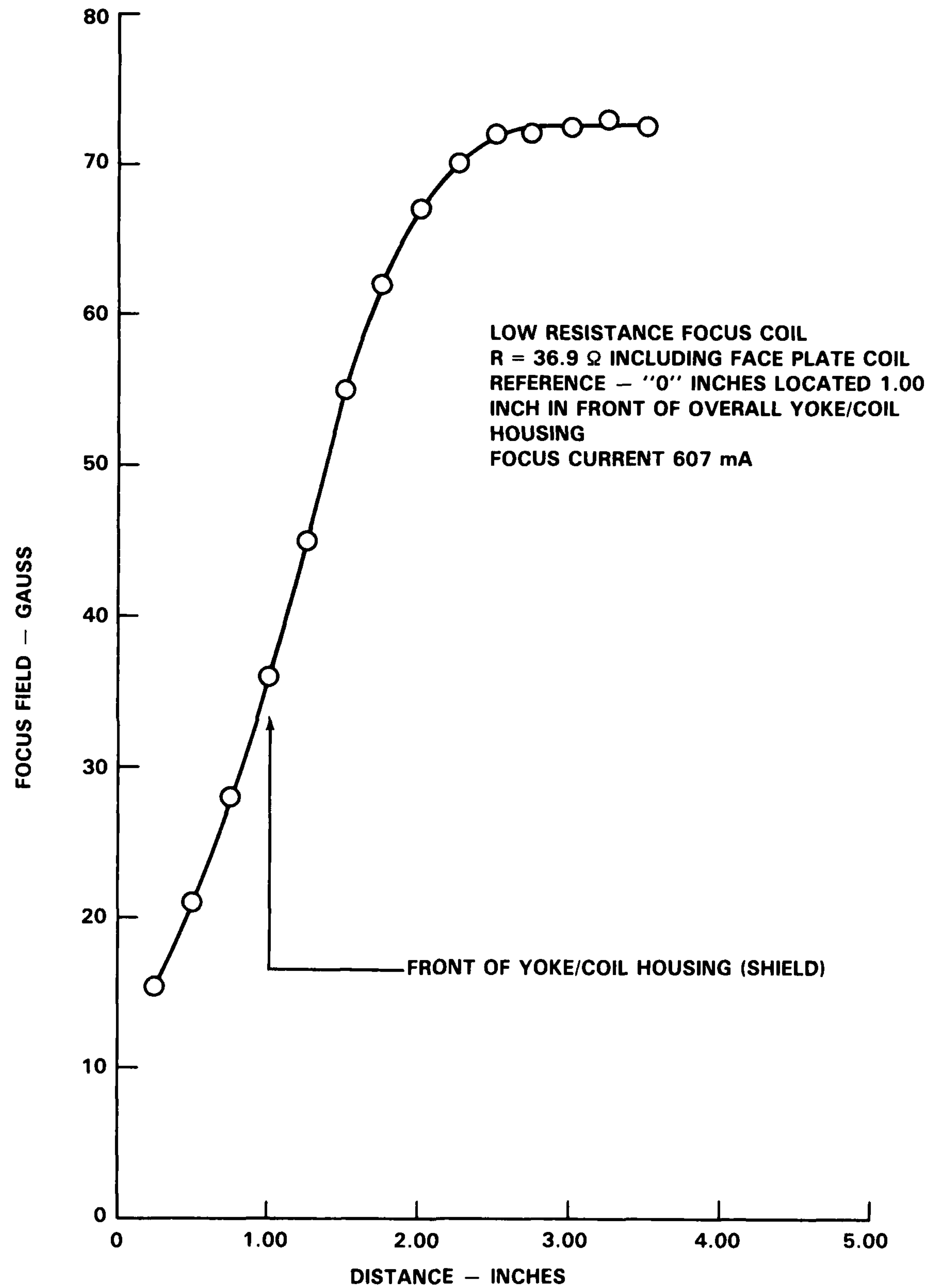

FIGURE 3. MAGNETIC FIELD FLUX PLOT — LOW RESISTANCE FOCUS COIL

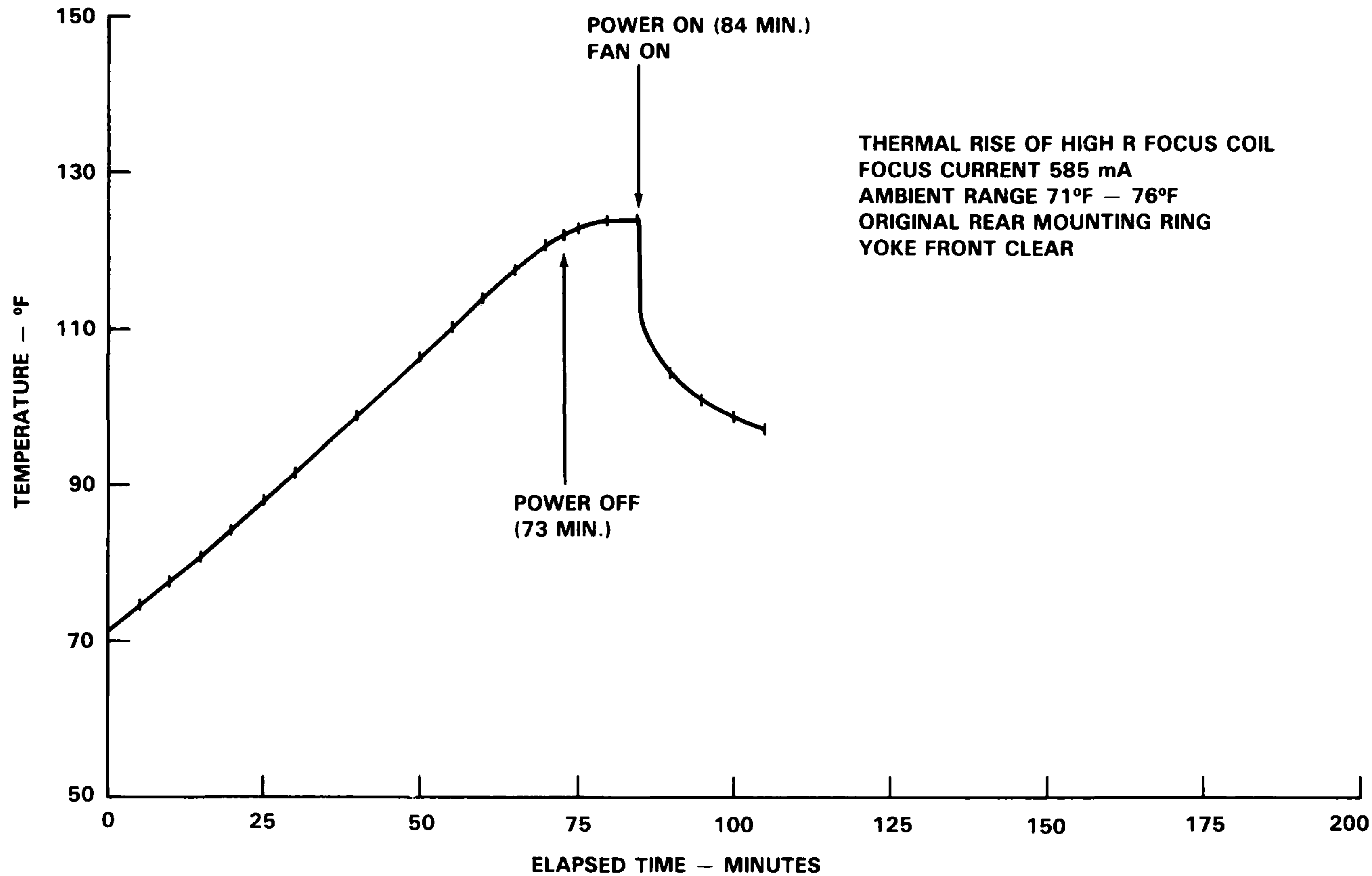

FIGURE 4. THERMAL CHARACTERISTIC — HIGH R COIL

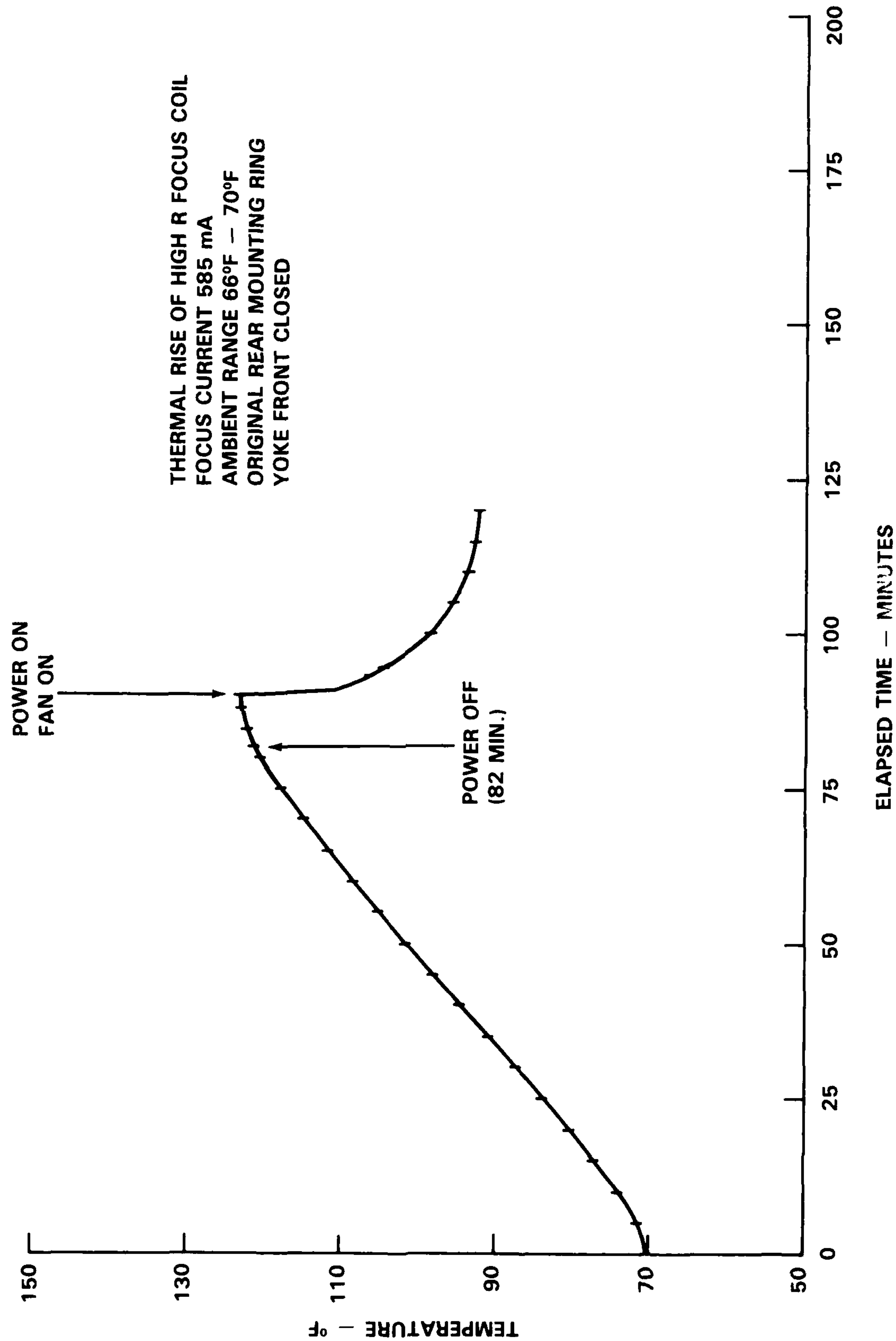

FIGURE 5. THERMAL CHARACTERISTIC — HIGH R COIL

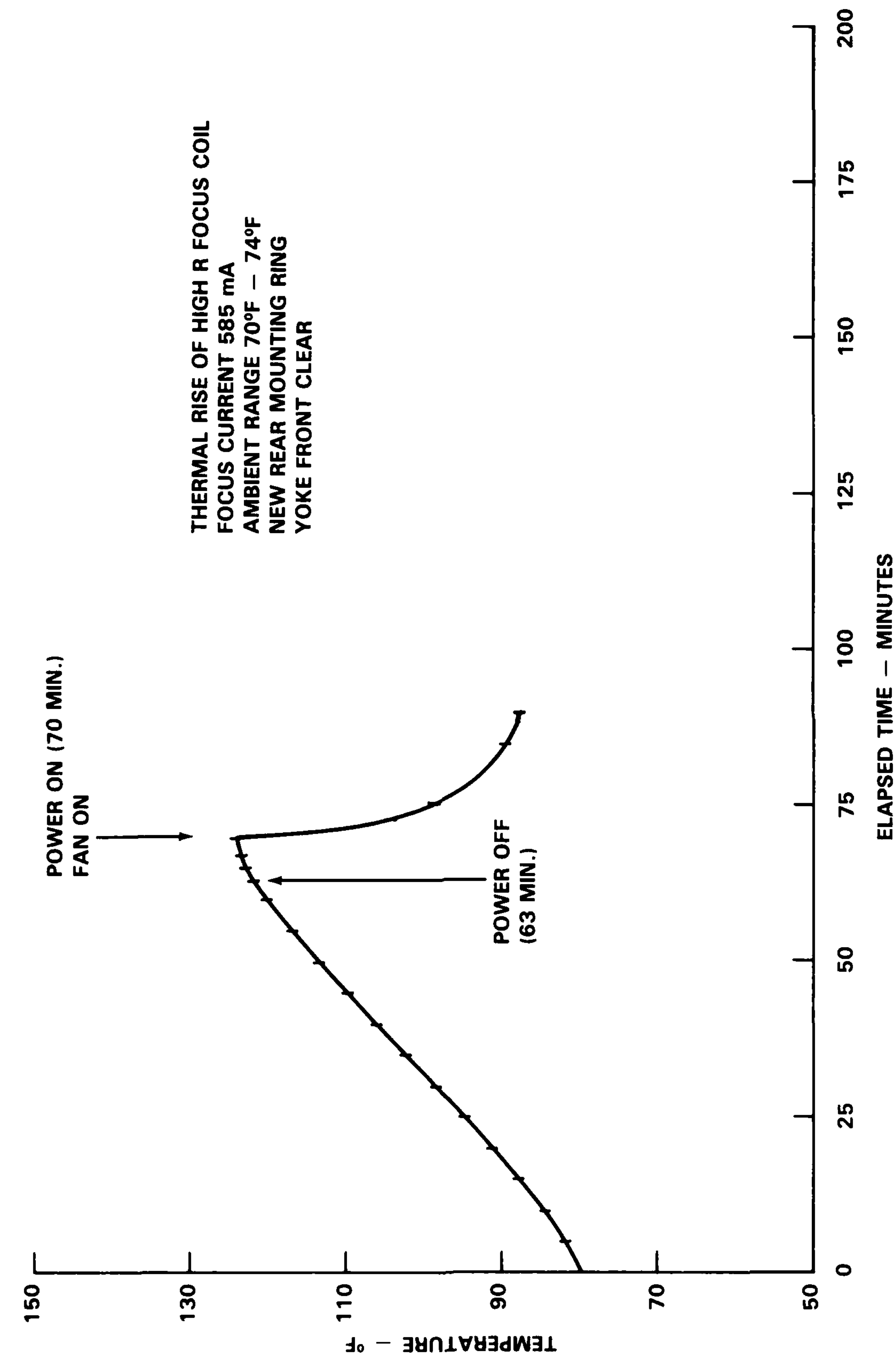

FIGURE 6. THERMAL CHARACTERISTIC — HIGH R COIL

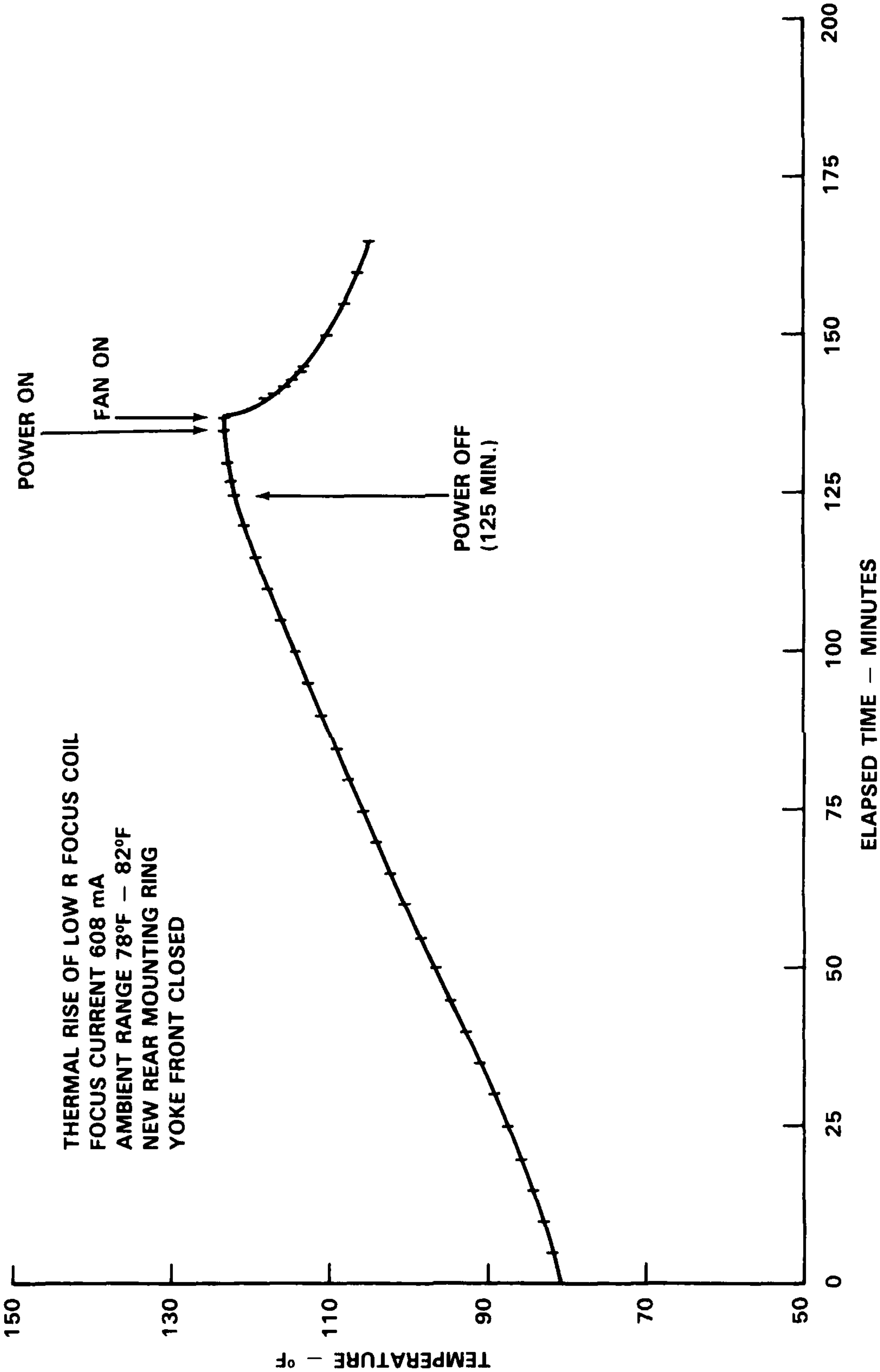

FIGURE 7. THERMAL CHARACTERISTIC — LOW R COIL

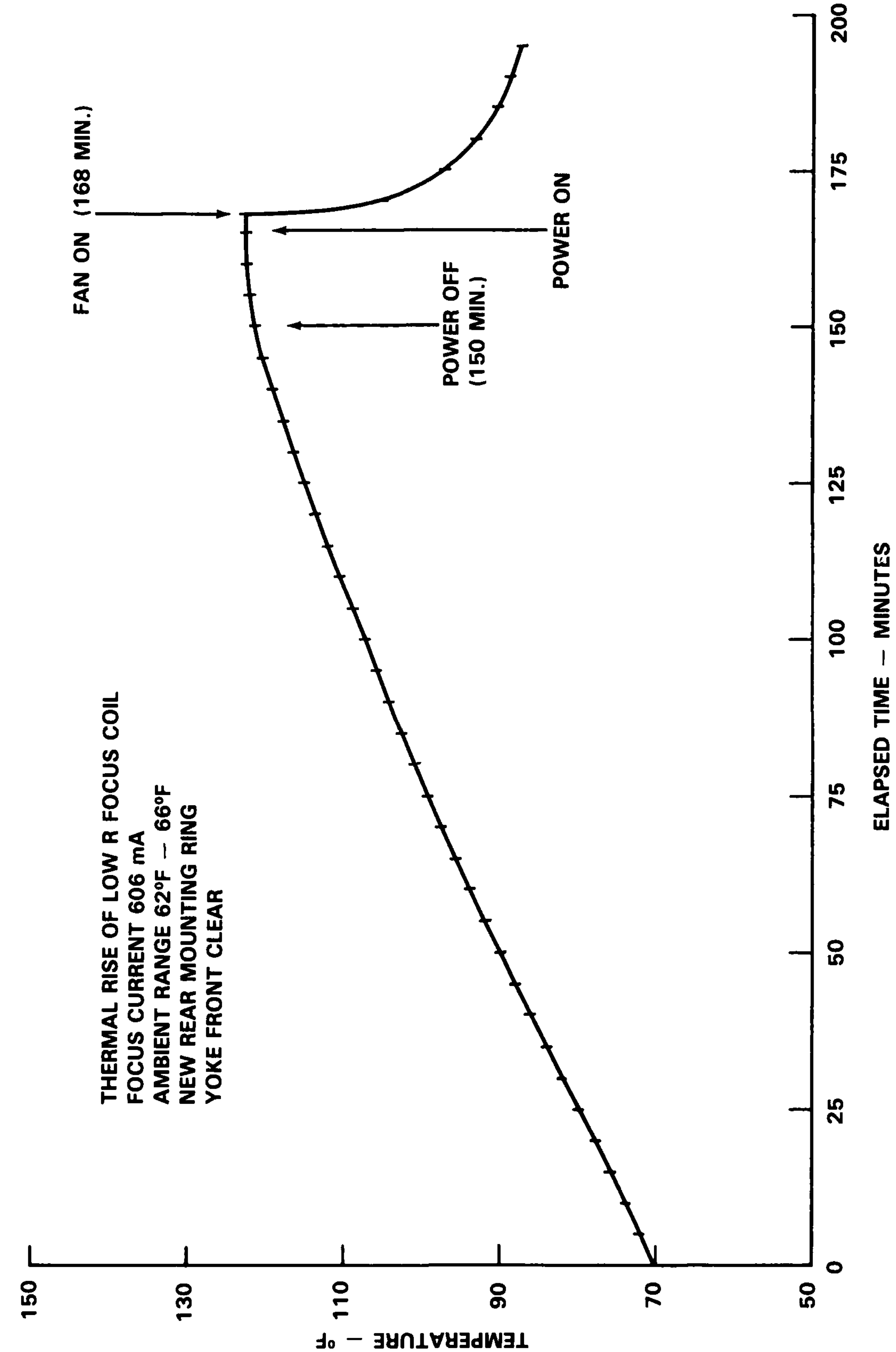

FIGURE 8. THERMAL CHARACTERISTIC — LOW R COIL

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